



US Army Corps
of Engineers
Detroit District

Great Lakes Update

1998 Annual Summary

What a difference a year can make. In 1996 and 1997, water levels were significantly above average and the winters of 1995-96 and 1996-97 were severe snow makers. During 1998, water levels plunged to near or below average levels on the Great Lakes. The 1997-98 winter was one of the mildest on record.

Precipitation and Temperatures

Although the lakes dramatically declined, especially during the summer, the lakes still tended to follow their general seasonal pattern; that is, rising in the spring, peaking in the summer and declining in the fall to a low in the winter. This pattern is depicted by the long-term average plots shown on the hydrographs contained in the *Monthly Bulletin of Lake Levels for the Great Lakes*.

Due to an El-Nino, the winter of 1997-98 was one of the top five mildest on record. Many cities within the Great Lakes region recorded record daily highs, record warm lows and record monthly average temperatures. Several cities never saw single-digit temperatures for the first time in modern history. The Great Lakes responded in kind through the formation of minimal ice cover. This double-edged sword eliminated the threat of ice-jam flooding in the connecting channels, but opened the lakes to greater evaporation and storm wave erosion.

The weather patterns remained dry as lakes Superior, Michigan and Huron continued to experience several months in succession of below average precipitation. The combined result has been a dramatic drop in water levels on all the Great Lakes; most notably the fall of Lake Superior to nearly a foot below its long-

term average (LTA), ending the year hovering around the Low Water Datum of 601.1 feet. This becomes a concern for everyone from the pleasure boater and riparian, to the shipping and hydropower industries. Lakes Michigan-Huron, St. Clair and Erie are all approaching their respective LTA's for the first time since April of 1996, having fallen 1-2 feet since the near record highs of mid-1997.

Due to dryer conditions during the latter part of 1997 and in 1998, lake levels fell significantly from their beginning of year starting points. Annual precipitation over the Great Lakes basin for 1998 was below normal based on preliminary records of the U.S. National Weather Service and Canadian Atmospheric Environment Service. Except for January and March, all months of 1998 received below normal precipitation. Total basin-wide precipitation for 1998 was 31.16 inches, or 1.4 inches below normal. Figure 1 below, compares the monthly precipitation for 1997 and 1998 to the long-term average for the entire basin.

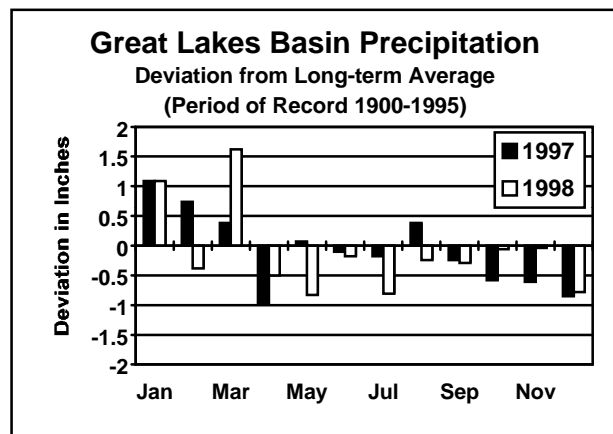


Figure 1

Lake Levels

The *Monthly Bulletin of Lake Levels for the Great Lakes*, which fosters this annual summary, graphically shows the fluctuations of water levels on the Great Lakes for 1997 and 1998. Lake Superior levels started 1998 at 601.80 feet, about 3 inches above its January LTA, and also about 6 inches below the beginning of January 1997 level. Lake Superior levels remained slightly above average through April dropping below average in May. Starting in March levels rose gradually peaking in July at 601.80 feet, about 4 inches below its July LTA and about 13 inches below the 1997 peak. From July through December levels fell, ending the year at 600.89 feet, about 11 inches below its LTA for the month, and about 2 inches below the Low Water Datum (LWD) of 601.1 feet. The last time Lake Superior levels ended the year below LWD was in 1926.

Lakes Michigan-Huron levels began the year at 579.89 feet, about 15 inches above its January LTA, and about 2 inches below the previous January starting level. These lakes peaked in June at 580.48 feet, about 13 inches above the June LTA and about 11 inches below the 1997 July peak. Levels then declined through December ending the year at 578.38 feet, about 4 inches below the LTA for the month. Lakes Michigan and Huron are considered as one lake hydraulically due to the connection at the Straits of Mackinac.

Lake St. Clair levels started the year at 576.00 feet, about 17 inches above its January LTA, and about 6 inches below the beginning 1997 level. The seasonal rise peaked early in April at 576.41 feet, about 25 inches above the LTA and about 7 inches below the 1997 June peak. Levels fell through December ending the year at 573.79 feet, about 2 inches above its LTA for the month.

Lake Erie levels began the year at 572.41 feet, about 19 inches above its January LTA, and about 3 inches below the beginning January 1997 level. The levels peaked in April, earlier than usual, at 573.88 feet, about 28 inches above the LTA, and about 6 inches below the 1997 June peak. Levels declined through December, ending the year at 570.83, its LTA.

Lake Ontario started the year at 244.68 feet, about 1 inch above its January LTA, and about 7 inches below the January 1997 starting level. The lake reached a peak in April, earlier than usual, at 247.57 feet, about 16 inches above the LTA, and about 4 inches above the 1997 May peak. Levels then declined through December, ending the year at 243.64 feet, about 11 inches below its LTA for the month.

Storms

Weather events across the Great Lakes in 1998 were remarkable compared to "average" years leading into the mid-1990's, with the most outstanding feature being the increased strength of storms in the area. Possibly as a direct result of El-Nino related warm conditions this past winter and spring, the atmosphere has become more volatile, especially over the past year. The Great Lakes experienced storms packing more wind, which created rarely-seen storm rise heights on the lakes. This is illustrated by the 11-foot difference in water levels between Toledo, Ohio and Buffalo, New York that occurred on November 10, 1998. The hurricane-force winds (gusting to 94 mph at Mackinac Island on November 10th) was the worst storm to hit the Great Lakes in five years and was similar in strength and path to the "Winds of November" storm of 1975 that claimed the Edmund Fitzgerald. The most remarkable storms of 1998 are revisited below.

A low pressure system formed in southeast Colorado on April 6th. During the next two days the relatively weak system drifted northeastward toward Chicago. Late on April 8th, the system tapped a strong jet stream and warmer air to rapidly strengthen near Columbus, Ohio. By April 9th, the intensifying east winds teamed with high water levels to cause lakeshore flooding and erosion on lakes Erie and St. Clair, and on Saginaw Bay and Green Bay. The mean water level on western Lake Erie rose 43 inches with the storm. The storm generated waves, estimated at 10 feet, added to this rise. Accompanying the gale-force winds were soaking rains that inundated the southern lakes region with 1.25 to 1.50 inches of chilly rainwater.

On November 9th, a storm system again began to form in southeast Colorado. Due to advances in

meteorological modeling, the storm system was pegged to explosively strengthen and head toward western Lake Superior by the 10th and 11th. Wind speeds averaged in the 50 and 60 mph range with the strongest gust of 94 mph observed at Mackinac Island in northern Lake Huron. Shipping was suspended across the Great Lakes and the St. Marys River was closed to commercial navigation as the storm roared across western Lake Superior. Figure 2 shows movement of the storm through the Great Lakes basin area.

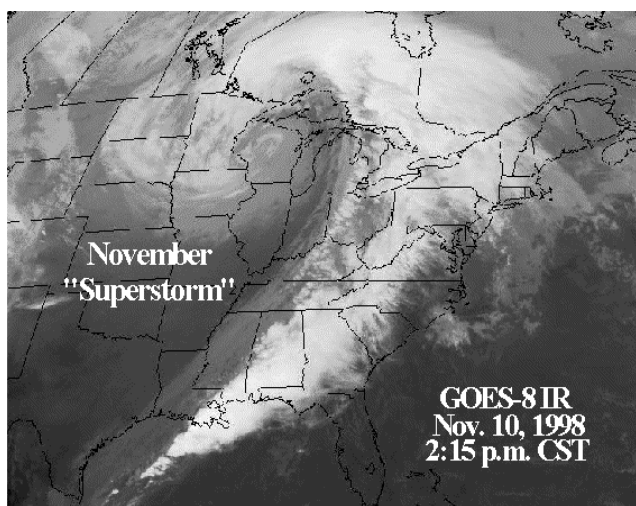


Figure 2: November 10, 1998 Storm (From U.S. Dept. of Agriculture, Weekly Crop Bulletin)

Lake Superior Regulation

During 1998, the International Lake Superior Board of Control (ILSBC) continued to use Regulation Plan 1977-A as the primary basis for determining Lake Superior outflows. Flow changes resulting from the monthly regulation of Lake Superior are accomplished by varying the amount of water allocated to hydropower production, and when necessary, by opening or closing gates in the Compensating Works at the head of the St. Marys Rapids. With only March, June, October and November incurring above average precipitation, the resultant dry basin conditions caused a significant decline in Lake Superior levels beginning in July. Except for March, outflows were below average, allowing the maintenance of a one-half open gate setting, or its equivalent, throughout 1998 (except for a brief period at the end of July when a one gate setting was used to permit repairs to gate seals).

Outflows ranged from a high of 69,600 cubic feet per second (cfs) in March to the minimum Plan 1977-A flow of 55,100 cfs during the months of September through December. Figure 3 compares the monthly Lake Superior outflows in 1997 with the long-term average flows (1900 - 1989 Period of Record).

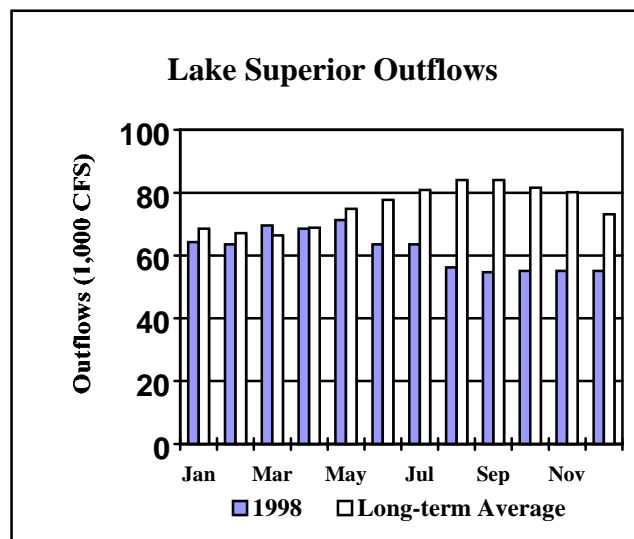


Figure 3

Lake Superior levels fell to 601.08 feet on November 5, 1998. This was the first time the lake was below the Low Water Datum of 601.1 feet since the January through May 1990 period. Levels continued to hover around LWD through December.

Scheduled repairs to Gates 9 and 10 of the Compensating Works resumed in May 1998 and were completed in September. Repair of a crack in Pier 17 and installation of a slurry wall at the south abutment to control seepage was also completed during 1998. This work completed the Compensating Works repair program. Due to the lower lake levels, it was not necessary to limit gate openings as was done in 1996 and 1997 to assure safe access by the Contractor's personnel and equipment to the upstream side of the gates during the repair period.

Lake Ontario Regulation

As 1997 came to a close, the weather was on the dry side for both the Lake Ontario and Lake Erie basins. Precipitation during December 1997 was below average over the Lake Ontario basin, and about average over the Lake Erie basin. The December 1997 mean level for Lake Erie was 572.47 feet, about

20 inches above its LTA. Lake Ontario's December 1997 mean was about 2 inches above its LTA at 244.72 feet.

Entering 1998, Lake Ontario levels continued to decline, reaching a low of 244.62 feet, about 1 inch above average on January 2, 1998. The January 5 - 9 ice storm, high Lake Erie outflows and other storm systems later in the month combined to establish a new Lake Ontario record high supply for the month. During the ice storm, many hydropower lines and transformers were damaged in eastern Ontario, western Quebec and upstate New York. The inability to transmit hydropower led to drastic cutbacks in the turbine flows, beginning first at the Beauharnois-Cedars hydropower complex in Montreal and then at the Moses-Saunders powerhouse between Cornwall, Ontario and Massena, New York.

Once the hydropower facilities were restored, the outflows were maximized as much as possible taking into consideration flow constraints due to low Lake St. Lawrence levels at various times, reduced outflow capacity from the ice storm effects and the ice cover on the St. Lawrence River. In spite of these constraints, the average outflows were much higher than those specified by Regulation Plan 1958-D. The level of Lake Ontario by the end of January was near 246.06 feet, about 17 inches above average for this time of year. After evaluating current and forecast conditions for Lake Ontario (along with projected high supplies from Lake Erie), the International St. Lawrence River Board of Control (ISLRBOC) recommended to the International Joint Commission (IJC) that Criterion "k" should be invoked. This criterion states that Lake Ontario will be operated strictly for the benefit of the riparians both upstream and downstream of the St. Lawrence River. The IJC invoked Criterion "k" on February 3.

The Ottawa freshet occurred in late March and forced significant reductions in Lake Ontario outflows due to extensive flooding in the downtown Montreal area. The outflows were reduced from a high of about 360,000 cfs to about 166,000 cfs. The snowmelt in the Ottawa River basin and the other tributaries occurred much earlier than usual. After the freshet, outflows were incrementally increased in consideration of downstream conditions, and reached a high of about 350,000 cfs. This high outflow rate was the maximum allowable without causing extreme

velocities on the St. Lawrence River that would result in the stoppage of commercial navigation activities. Figure 4 shows a comparison of 1998 monthly outflows with the long-term average monthly outflows (1900 - 1989 Period of Record).

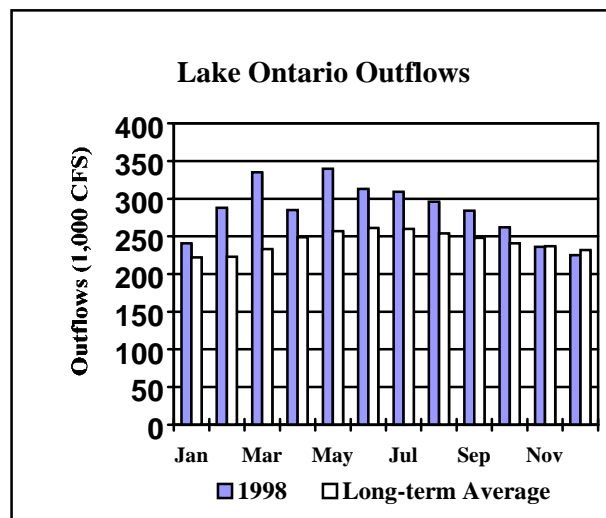


Figure 4

During this period of high discharges, the Lake St. Lawrence area, which is just upstream of the Moses-Saunders powerhouse at Massena, New York, recorded extreme low water conditions due to the high drawdown of water at the powerhouse. Many recreational boating complaints were received by both the U.S. and Canadian Regulation Representatives.

Lake Ontario reached its peak level of 247.57 feet during April 17-23. The monthly mean lake level was 247.34 feet for the month of April as compared to the Criterion "h" level of 247.28 feet. The preproject level would have been at 249.24 feet, about 1.67 feet higher than the actual peak level.

In mid-June, the Lake Ontario level and supply appeared to have improved considerably and consequently the IJC revoked Criterion "k". Water supplies from Lake Erie remained above average during this time but had decreased considerably in comparison to conditions a year ago. By the middle of August, precipitation to the entire Great Lakes basin was much below average. Consequently the levels of all the Great Lakes had decreased as well. At this time, the levels for Lake Erie and Lake Ontario were about 15 inches and 2 inches above their seasonal average, respectively.

The precipitation in the Ottawa River and the Quebec region also declined considerably during this period. By mid-September, the Lake Ontario level had declined to its seasonal average. The ISLRBOC decreased the outflow below plan flow for three weeks, from late August to mid-September, and for two weekends in October, to accommodate the marinas in their efforts to remove the boats from the St. Lawrence River. The water level fell below chart datum in the Port of Montreal in late October and remained there for most of November. The ISLRBOC increased the outflow above plan flow to accommodate their needs during this time. The levels of Lakes Erie and Ontario continued to decrease ending December, at 570.83 feet, at the LTA, and 243.64 feet, about 11 inches below the LTA, respectively.

Currently, the Great Lakes region is still seeing dry conditions and the projection for Lake Ontario is for below average levels into the following year under normal supply conditions.

Meetings With the Public

On June 23, 1998 the International Lake Superior Board of Control held its annual public meeting in South Haven, Michigan. Prior to the meeting members of the Board visited several shoreline areas near South Haven affected by erosion.

The ISLRBOC held its public hearing this year at Sackets Harbor, New York on June 16.

On September 29, 1998 the International Niagara Board of Control (INBOC) held a public meeting at Niagara Falls, Ontario.

Commercial Navigation

As of the end of November 1998, tonnage passing through the Soo Locks at Sault Ste. Marie, MI was about 4% below the comparable 1997 tonnage. United States and Canadian vessels carried about 57.8 and 13.6 million short tons of cargo respectively, while foreign vessels carried about 5.6 million short tons. Foreign cargo tonnage was up about 26% over comparable 1997 tonnage. Through November, a total of 4,113 cargo vessels had transited the locks, as compared to 4,231 passages the

previous year. Of these 2,445 passages were U.S.-flagged vessels, 1,061 were Canadian, and 607 were foreign vessels (ocean-going or "salties"). In addition to the cargo vessels, there were also 5,126 transits by other types of vessels, such as pleasure craft, tour boats, Coast Guard, and scientific research vessels. The Corps of Engineers has the authority to keep the locks open until January 15, 1999, should shipping interests request it.

The Canadian lock at Sault Ste. Marie, Ontario reopened on July 14, 1998 after completion of a major reconstruction program. It had been closed since July 27, 1987 as the result of a major structural failure in the southwest wall. Parks Canada started the rehabilitation of the lock in September 1996. The present lock has a smaller chamber than the original lock and is designed for passage of pleasure craft. 2,296 vessels (pleasure craft and tour boats) carrying 69,923 passengers had transited the lock by October 7, 1998 when it closed for the season. It is expected to reopen in mid-May 1999. See Figure 5.



Figure 5: Reconstructed Canadian Lock looking west at the International Bridge

According to the St. Lawrence Seaway Development Corporation's preliminary figures through mid-December 1998, tonnage passing through the Lake Ontario-Montreal section of the Seaway was up about 6% over 1997 at about 38.8 million metric tons (MMT). Vessel traffic was up about 15% over 1997 at 3,223 (1,747 lakers and 1,476 ocean vessels).

Seaway officials reported preliminary information on a number of individual cargoes as of mid-December 1998, including: iron ore (up 8% to about 10.9 MMT); grain (down 7% to about 12.5 MMT); coal

(down 58% to about 0.22 MMT); and petroleum products (up 44% at about 1.6 MMT).

1998 Great Lakes Updates

In 1998 the following *Great Lakes Updates* were published:

“1997 Annual Summary”, Vol. No. 130, Published January 2, 1998.

“Impacts of El-Nino Conditions on the Great Lakes”, Vol. No. 131, Published April 2, 1998.

“Recreational Boating on the Great Lakes”, Vol. No. 132, Published July 2, 1998.

“Snowpack Contributions to Great Lakes Water Levels”, Vol. No. 133, Published November 2, 1998.

General Notes

All elevations shown in this article are referenced to the IGLD 1985 datum.

Information about Great Lakes water levels, outflows, and weather is available on the World Wide Web. The Internet address for the Detroit District's Home Page is as follows:

<http://www.lre.usace.army.mil>

Information is updated daily and monthly as required.